Introduction

For most of Sub-Saharan African countries, agriculture is and will remain for many decades an important factor for a sustainable development, poverty reduction and food security improvement (Ouma and Groote, 2011). In many African countries agriculture is an important source of income, employment, and raw material for small and medium industries. However, for the past three decades agricultural productivity in Sub-Saharan Africa has been the lowest in the world, leading to food insecurity and increase in poverty (Doss, 2006, Ouma and De Groote, 2011).

The green revolution that has enhanced agricultural yields in Asian countries has not been yet effective in most of African countries. Low productivity and low use of farm inputs, unreliable rainfall, drought, pest infection, crop disease, poor agricultural techniques and equipments, low soil fertility and poor infrastructures, are amongst the main factors that have affected yields (Ouma and De Groote, 2011; Suri, 2001).

One of the solutions to the declining agricultural productivity in developing countries in general and Africa in particular has been the promotion and the diffusion of improved agricultural technologies. For many decades, many African governments and non-governmental world organizations have been diffusing and promoting the use new agricultural technologies such as high yields crop varieties and fertilizer. However, despite many compelling success stories on the positive relation between the use of improved agricultural technologies and increase in yields as well as cereal productivity, many farmers are still using traditional agricultural technologies in general and low crop yield varieties in particular (Johannes, Vabia and Malaa,2010 ; Kudi et al., 2010).

In fact, correctly indentifying the factors that prevent small holders from adopting improved and high yielding crop varieties remains a challenge (Langyintuo and Mekuria, 2008). However, studies on the adoption of improved farming technologies in developing countries in general and Africa in particular have revealed that farmers do not have access to modern agricultural technologies such as improved crop varieties and fertilizer due to liquidity constraints or they find those technologies very risky. In addition, many farmers are poor and do not have or have limited access to credit and insurance markets.

The lack of rural financial markets has been one of the major constraints in the adoption of improved agricultural technologies in developing countries (Dercon and Christiaensen, 2011; Kudi et al., 2010; Dupas and Robinson, 2013).Therefore, the provision of micro-credit is generally perceived as an effective way to promote the adoption of improved technologies in developing countries (Simtowe and zeller, 2006).

For many decades, governments and non-governmental development organizations in low developing countries have tried to provide and improve rural financial services but with disappointing results (Armendariz and Murdoch, 2005). Agricultural subsidy programs implemented by many governments in late 1960s and 1970s, the creation and the promotion of microfinance institutions (MFs) since the 1980s and other financial services programs to boost agricultural and rural activities as well as help rural households graduate from poverty have failed or shown their limits (Adam and Vogel, 1986; Zeller, 2003; Andrews, 2006; Nagarajan and Meyer, 2005). As a result, the provision of financial services to rural poor remains a challenge in many developing countries in general and African countries in particular.

The lack of formal financial institutions has led poor households in developing countries to rely on informal credit markets, family members and friends to increase their productive

capacities, share risks and smooth their consumption over their life cycle (Diang, Zeller and Sharma, 2000). In addition, many households have been relying on migration and remittances as source of revenue and diversification as well as a way to protect themselves against credit and insurance market imperfection. Presently, international remittances constitute a second largest source of external finance after foreign direct investments. In addition, they represent almost two times the official foreign aid to developing countries (Bettin and Zazzaro, 2012; De Haas, 2006). Between 1990 and 2010, international remittances to Africa reached nearly $ 40 billion ((Mohapatra and Ratha, 2011)

Remittances are viewed by the new economics of labor migration (NELM) theory as a substitute for formal or informal credit that may enable households to overcome liquidity constraints and invest in new technologies and activities (Wouterse, 2010; Taylor and Wyatt, 1996). By reducing risk and credit constraints, migration and remittances can increase the use of improved agricultural technologies (Zahonogo, 2011; Quinn, 2009).

The relation between migration, remittances and the adoption of improved agricultural technologies has been examined by Quinn (2009) who used data from Mexico and Mendola (2006), using data from Bangladesh. To our knowledge, no study has so far examined whether or not migration and remittances can help African rural households reduce credit and risk constraints and invest in improved agricultural technologies, regardless of the significant number of migrants and the importance of remittance flow in African countries.

The purpose of this study is to analyze the impact of migration and remittance on the adoption of improved agricultural technologies in rural Senegal. The rest of this study is organized as follows: we present the literature review, followed by the conceptual framework

and the methodology. Then we present the empirical results and finally focus on conclusion and policy implications.

Literature review

Remittances are defined by Plaza, Navarrete and Rhata (2012) as money or goods that are transmitted to households back home by those working away from their communities of origin. They include both international and internal person to person transfers of resources, both in money and in-kind often sent by migrants workers.

Remittances have been an important source of income for many urban and rural households in many developing countries. For the past two decades, the amount of international remittances sent in developing countries has significantly increased from US$ 68 billion in 1990 to US$ 325 billion in 2010(Imai et al., 2012; Bettin and Zazzaro, 2012; Anyanwu, 2011). During the same period, international remittances to Africa increased from US$ 9.1billion to nearly $40 billion (Mohapatra and Ratha, 2011). Furthermore, internal remittances constitute also an important component of rural livelihoods in many developing countries (Garip, 2012, Reardon, 1997).

There is a wide literature on the relation between migration, remittances and the standards of living of recipient households and communities. Many empirical studies have found that remittances sent to relatives have improved food security and the wellbeing of recipient households as well as reduce poverty in the community (Babatunde and Martinetti, 2011). In addition, some researchers argue that remittances can also increase access to education and health in the recipient community (Bettin and Zazzaro, 2012; Yang, 2008; De Haas, 2006; Adams and Page, 2005; Ncube and Gomez, 2011; Blosh, 2008).

Furthermore, Ponsot and Obegi (2010) have found that in case of unexpected event, remittances can be used by the recipient households as insurance. Studies have also proved that remittances have a positive impact on aggregate investment, income and employment (Bjuggren,

Dzansi and Shukur, 2010; Glystos, 2002). In his study on Albania, Ang (2009) found that remittances had a positive impact on economic growth at the national level but not on rural development. Using data from Burkina Faso, Wouterse (2010) have found that only continental migration had a positive relation with farm technical efficiency in cereal production. Study by Miluka et al. (2010) in Albania revealed that families with migrant workers work fewer hours in agricultural production. In addition, households with migrants do not appear to invest in productivity-enhancing and time saving farm technologies in crop production.

However, despite the positive impact of remittances on livelihoods of recipient households and communities found in many empirical studies, the impact of remittances on sustainable and long term economic growth remains a big debate. For new economics of labor migration (NELM) scholars, migration and remittances play an important role in developing countries. In countries where households have no or have limited access to financial markets, migration and remittances constitute an important source of investment capital (Richter, 2008; Wouterse, 2010). In addition, remittances can be considered as a solution to liquidity and credit constraints. Therefore, remittances can allow rural households invest productive activity and promote growth (De Haas, 2006; Taylor, 1999; Garip, 2012). Remittances can also enhance growth through capital accumulation, increase in labor growth and total factor productivity (Imai et al., 2012).

On the contrary, some scholars have shown that migration leads to the withdrawal of human capital and the breakdown of traditional, stable villages, communities and regional economies (De Haas, 2006). In addition, given that remittances are not spent or invest in productive activities but in luxury and other consumption goods, migration discourages the economic growth of migrant countries (De Haas, 2006; Rubenstein, 1992).

Methodology

Conceptual framework

Many rural households in developing countries in general and Sub-Saharan Africa in particular are poor and do not have or have limited access to financial markets. Studies have shown that access to credit in rural areas remains one of the major constraints in the adoption of new technologies (Dercon and Christiaensen, 2011; Kudi et al., 2010; Gine and Yang, 2009; Dupas and Robinson, 2013).

The conceptual framework for this study is based on the New Economics of Labor Migration theory (Stark and Bloom, 1985). According to this theory, migrants play the role of financial intermediaries enabling rural households to overcome the constraints based on their ability to achieve the transition from familial to commercial production. In addition, migration constitutes a means for rural household to overcome liquidity constraint (Zahonongo, 2011). Therefore, remittances can play an important role by providing rural households with liquidity and credit-constraint the necessary funding to acquire new technologies and invest in more risky activities.

Based on this theory, researchers on migration, remittances and agricultural investments are motivated by the risk and credit hypotheses (Quinn, 2009). According to the risk hypothesis (Stark and Bloom, 1985; Taylor and Wyatt, 1996), migration is a strategy adopted by households to ensure against the risk of agriculture failure. In case of agriculture failure, due to the adoption of a new technology, migrants can send money to their families to compensate for agricultural losses. As a result, risk adverse rural households with migrants can be motivated to invest more in new agricultural technologies.

However, the credit hypothesis suggests that remittances are the crucial factor as they provide the necessary funding to credit-constraint households to purchase new technologies (Quinn, 2009). Based on these hypotheses, if credit and risk constraints are severe and migration enables families with migrants to overcome them, we expect the number of migrants and remittances per household or whether or not households receive remittances to be positively related to the probability of adopting new technologies.

Data and sources

The data used for this study is from the household survey conducted by the World Bank in partnership with the French Cooperation and the International Fund for Agricultural Development (IFAD).The survey was conducted through the RuraLStruc Program between 2007 and 2008 in seven countries (Mali, Senegal, Kenya, Morocco, Madagascar, Nicaragua, and Mexico).

The main objective of the RuraLStruc Program was to provide a better understanding of the implication of liberalization and economic integration for agriculture and rural development in developing countries. It also illustrates the situation of rural economies in terms of income, diversification and overall transformation (Losh, Freguingresh, and White, 2011). However, this study focuses on Senegal.

The sampling process for the surveyed households followed a multistage systematic random sampling procedure. The first was the selection of regions or districts for the survey. From the regions selected, a multi-stage random sample of farm households was selected with a number of random localities to be surveyed selected first and from these, a number of random households, targeting a sufficient number of households per locality allowing representativeness at local level. The choice of these regions was based on the importance of agricultural activities,

market access, the size and population density and the ability to illustrate different rural household situations (Kirimi et al., 2010; Ba et al., 2009).

The regions selected were the Delta region, the Central-North Basin (CNBA), the South-East Basin (SEBA) and, the Upper and Middle Casamance (HMC). From these regions, 980 surveys were carried out in randomly selected households: 236 households in the Delta, 253 in CNBA, 252 in SEBA and 239 in HMC (Ba et al. 2009). However, due to missing information in the original data set, a sample of 897 is used for this study.

Table 1 presents the number of households with migrants and remittances. However, table 2 includes the descriptive statistics of the key variables used in the empirical model.

From table 1, 421 or 46.9% of households in the sample had migrants; 260 of these households had migrants in the capital or in the other cities. However, 161 of them had migrants out of the country. The descriptive statistics in table 2 show that almost 70% of the households in Senegal did use improved seeds and/or fertilizer. Households with migrants had on average one migrant for each type of migration. Based on the entire sample size, 20.2% of households did receive local remittances and 17.1% received remittances from outside of the country.

Furthermore, 96.1% in were males. In addition, the average household size was 9. Households had on average 3 active males and 3 active females. The average age of the household head was 51. 15.3% of the households sold their products through market contracts, 21.1% used mutual or unpaid labor and 11.5 % had access to animal traction. In addition, 22.9% of the households had access to irrigation. 20.4% of the households in the survey owned land. However, 88% of the total land, owned and rented was under farming. In addition, 74.1 percent of the households were classified as extremely poor.

Data Analysis

This study used a three-stage least squares model to address the potential endogeneity problem that may arise from using migration and remittances as explanatory variables.

In fact, a major concern in the majority of the analyses of the casual impact of migration and remittances is endogeneity (Nguyen and Punamarisi, 2011). Given that the error terms and the explanatory variables are likely correlated due to several reasons such as reverse causality, omitted variable or sample selection bias; running a simple OLS of household outcomes with migrations and remittances as explanatory variables could give biased estimate of the impact. For instance, in the analysis of the impact of migration and remittances on household income, endogeneity problem arises from the fact that migration and remittances are jointly determined with other activities or sources of income (Brown and Leeves, 2007, Zhu et al., 2011).

Various instruments have been used by researchers to deal with endogeneity in the study of the impact of migration and remittances. Brown and Leeves (2007) used predicted rather than actual number of migrants for each household as instrument in their analysis of migration, remittances and household income in Fiji and Tonga. In addition, highest educational level in the household and family chain migration were used by Mendola (2006) as instruments in his study on the relation and technological change in rural Bangladesh

Furthermore, Nguyen and Purnamarisi (2011) have used historical network in their study on migration and remittances on child outcomes and labor supply. The choice of the historical network is that large initial migration network can lower the cost of subsequent migration, through information or through financing, and thus induce more migrations. The idea behind this instrument is that past migration networks do not influence the household outcome directly other than through their likelihood of having migrant members.

In his study on migration and remittance in Mexico, Garip (2012) used the interaction between community migration prevalence and distance to the U.S. border as instrument. According to the author, the intuition for using this instrument is that individual living far from the border face higher costs to migration. This cost should be lower in communities with high migration prevalence, as prior migrants provide useful information or help.

Other instruments such as migration contacts, the percentage of adults from community with migration experience, the number of migrants in the household, the dependency ration (the number of non-workers divide by the numbers of workers in the household), the proportion of returned migrants among non-migrants, and ever the head of the household has ever migrated as well as the distance between the household location and nearest paved road have been used to deal with migration and remittance endogeneity (Quinn, 2009; Zhu et al., 2011).

Model specification

Following Quinn (2009), let the probit model that test the impact of migration and remittances and transfers be expressed as:

$$\Pr(S_i \neq 0 | X_i, M_i, R_i,) = \phi(X_i\beta_1, M_i\beta_2, R_i\beta_3) \quad (1)$$

Where S_i is a binary variable representing the adoption decision for each household; M_i and R_i are the total number of migrants and the amount or remittances received by household respectively. X_i is a vector of other variables that may influence the adoption decision such as farm and household socio-economic characteristics, and ϕ is the standard cumulative normal distribution. In this study, R_i is a binary variable indicating whether or not a household has received remittances.

If we assume that migration and remittances are exogenous, a probit model can be estimated to capture the impact of migration, remittances and public transfers on the adoption of the technology. The probit model can be expressed as

$$S_i = \beta_0 + \beta_1 X_i + \beta_2 M_i + \beta_3 R_i + \varepsilon \quad (2)$$

If the above assumption is violated, a three-stage least squares model will be estimated by indentifying instruments variables for M_i and R_i. In the first and second stages, an OLS or a Probit equation is estimated, depending on the nature of the endogenous variable, for each endogenous variable. In our case since the variable remittances is a binary variable, a probit model will be estimated for the remittances equation and OLS for the migration equation. The two equations can be expressed as:

$$M_i = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \varepsilon \quad (3)$$

$$R_i = \gamma_0 + \gamma_1 X_i + \gamma_2 W_i + \varepsilon \quad (4)$$

Where Z_i and W_i are the vectors of instruments for M_i and R_i respectively.

In the third stage, the predicted values of M_i and R_i($\widehat{M}_i$ and $\widehat{R}_i$) from equations (3) and (4), are included as explanatory variables in the probit equation, equation (2), instead of M_i and R_i.Therefore, equation (2) can be express as:

$$S_i = \delta_0 + \delta_1 X_i + \delta_2 \widehat{M}_i + \delta_3 \widehat{R}_i + \delta_4 T_i + \mu \quad (5)$$

The gain from using the 3SLS model is that the errors in equation (5) are corrected for the covariance between the migration and the remittances equations.

Instruments

The choice of instruments in this study is based on the existing literature and the different instruments used in the previous studies on migration and remittances (Quinn, 2009; Mendola, 2006; Zhu et al., 2011).

The set of instruments used for migration in this study includes: the migration percentage, which is the percentage of adults from community with migration experience; household access to transportation, family chain migration represented by the presence in the household of more than one long term migrants and; the membership of the household head in the family with migrants to a social network (other than agricultural production network). Furthermore, the number of migrants in the household and the dependant ratio (the the number of non-workers divide by the numbers of workers in the household) were used as instruments for remittances. These variables do not directly influence the household adoption behaviors, but through migration and remittances.

The number of adults in communities with migration experience is more likely to have a positive impact on migration. In addition, social networks, between village neighbors and within families, are more likely to reduce migration costs. Furthermore, people with experience of migration, within and outside the family, are more likely to move and settle better where they go (Mendola, 2006). With easy access to transportation, people can easily move to different locations

Empirical Results

The results from 2SLS and 3SLS estimation are presented in tables 3, 4, and 5. Tables 3 and 4 contain also the results from the different tests for the validity of the instruments used to address migration and remittances endogeneity.

Based on the different test results in tables 3 and 4, both migration and remittance variables are endogenous. In addition, the F-statistic from all the first stage regressions is very high, implying that our instruments are not weak. The validity of the instruments is also confirmed by the Hansen's over identification test.

The 2SLS as well the 3SLS estimation results in table 3 show that both internal and international migrations are positively related to the propensity of adopting new farming technologies, In contrast, the results in table 4 reveal that only households with international remittances were more likely to adopt new technologies. In addition, the 3SLS estimation results in table 5 confirm the results from the previous estimations. Both internal and international migrations are positively related to the adoption of new farming technologies. However, only households with international remittances were more likely to adopt new farming technologies.

These results can be explained by the fact that in many developing countries having a family member outside of the country, mostly in developed countries, is an assurance for a better future life for those left in the country of origin. In addition, generally households expect more remittances from migrants abroad than from those within the country. Therefore, the probability to invest in more risky and profitable activities will be higher for a household with a migrant abroad than the one with a migrant within the country.

Furthermore, male household head, farmers with marketing contracts, access to animal traction and irrigation as well as households with more irrigated land were more likely to adopt

the new technologies. However, very poor households and households with more cattle were less likely to adopt new the farming technologies.

Conclusion and implications

The adoption of new farming technologies represents an important means to increase productivity and improve the well being of millions of poor households in developing countries. However, due to risk and liquidity constraints, many farmers in Sub-Saharan Africa do not have access to these technologies. Risk and liquidity constraints remain the main reasons that prevent many farmers to benefit from these technologies.

The objective of this study was to investigate whether or not migration and remittances may help rural households reduce risk and liquidity constraints in Senegal. Using data from the World Bank Ruralstruc project, the empirical results from 3sls estimations show that households with either internal or international migration were more likely to adopt new farming technologies. However, only households with international remittances were more likely to adopt these technologies.

The results in this study show that migration and remittances might help households in the region under study reduce risk and liquidity constraints and invest more in productive activities. Therefore, the impact of migration on the economic development in general and rural areas in particular must be one of the major concerns of Sub-Saharan African leaders and researchers. Future research can be extended to other African countries and regions in order to capture the real impact of migration on rural and agricultural development. In regions where remittances have a positive impact on the development of rural activities in general and agricultural activities in particular, governments and other development organizations have to devise mechanisms and strategies to help rural households reduce the transactions cost related to remittances by implementing money transfer services close to the beneficiaries. In addition, other African

countries with inadequate transportation infrastructures can also experiment the mobile transfer, M-PESA, implemented in Kenya since 2007(Datta, Ejakait and Odak, 2008)

However, though migration and remittances may help households reduce risk and credit constraints; it should not be considered as a solution to the credit and liquidity constraints faced by rural households. In addition, increase in migration may cause shortage of labor or the abandon of farming activities in many rural areas which may reduce agricultural production, increase food insecurity and poverty. Therefore, governments and non-governmental world organization involved in the diffusion and promotion of modern farming technologies must devise strategies and plans to restore or provide rural areas with financial services.

References

Adams,R. and Page,J. (2005). Do international migration and remittances reduce poverty in Developing countries? World development, 33(10), 1645-1669

Adams,W.D. and Vogel,C.R. (1986). Rural financial Market in Low income Countries: Recent Controversies and Lessons. World Development, 14: 477-487

Andrews, M.(2006). Microcredit and agriculture: how to make it work. Mennonite Economic Development Associates (MEDA), Canada. http://www.ruralfinance.org/fileadmin/templates/rflc/documents/1164183856752_Microcredit_and_agriculture___how_to_make_it_work.pdf Accessed on October, 2013

Ang, A. (2009). Workers' remittances and its impact on rural development in the Philippines. Asia-Pacific social science review, 9(2): 63-77

Anyanwu, J.C. (2011), International Remittances and Income Inequality in Africa, Working Paper Series N° 135, African Development Bank, Tunis, Tunisia.

Armendariz, B. and Morduch, J.(2005). The economics of Microeconomics. The MIT Press Cambridge, Massachusetts London, England, pp 4-12

Ba, C.O., Diagana, B., Dieye, N., Hathie, Ibrahima, and Niang, M. (2009). Globalization and structural change in rural economies, RuralStuc program-Phase II report, Initiative Prospective Agricole et Rurale, Senegal

Babatunde, R.O. and Martinetti, E.C. (2011). Impacts of migrant remittances on food security and nutrition of Farming Households in Kwara State, Nigeria, Contributed paper for the International Conference: Shocks in Developing Countries. June 30 – July 1, 2011, Paris, France

Bettin, G. and Zazzaro, A.(2012). Remittances and financial development: substitutes or complements in economic growth? Bulletin of Economic Research, 64(4):509-536

Blosh, A.(2008). Zimbabweans in Britain: Transnational activities and Capabilities. Journal of Ethic and migration studies, 34(2):287-305

Bjuggren, P., Dzansi, J. and Shukur, G.(2010). Remittances and investment. Working paper No.206, The Royal Institute of technology. Centre of Excellence for Science and Innovation Studies (CESIS), http://www.cesis.se.

Brown, R. and Leeves, G. (2007). Impacts of International Migration and Remittances on Source Countr Household Incomes in Small Island States: Fiji and Tonga. ESA Working Paper No. 07-13 .Agricultural Development Economics Division. The Food and Agriculture Organization

Datta, D., Ejakait, A. and Odak, M. (2008). Mobile phone-based cash transfers: lessons from

the Kenya emergency response. http://www.odihpn.org/humanitarian-exchange-magazine/issue-40/mobile-phone-based-cash-transfers-lessons-from-the-kenya-emergency-response. Accessed on August 28

De Haas, H. (2006). Remittances, Migration and Social Development: A conceptual Review of the literature. Social policy development paper No 34, United Nations Research institute for Social Development

Dercon, S. and Christiaensen, L.(2011). Consumption risk, technology adoption and poverty trap: evidence from Ethiopia. Journal of Development economics, 96: 159-173

Diagne, A., Zeller, M., and Sharma, M. (2000). Empirical measurements of households' access to credit and credit constraints in developing countries: methodological issues and evidence, Discussion paper, food consumption and nutrition division, IFPRI, Washington, DC

Doss, C.R.(2006). Analyzing technology adoption using micro studies: limitations, challenges and opportunities for improvement. Agricultural Economics, 34:207-219

Dupas, P., and Robinson, J. (2013). Saving constraint and microenterprise development: evidence from a field experiment in Kenya. American Economic Journal: Applied Economics, 5(1):163-192

Garip, F. (2012). An integrated analysis of migration and remittances: Modeling migration as a mechanism for selection. Popul Res Policy rev, 31:637-663

Gine,X. and Yang,D.(2009). Insurance, credit, and technology adoption: field experimental evidence from Malawi. Journal of Development Econimics, 89:1-11

Glytsos, P.N. (2002). The role of migrant remittances in development: Evidence from Mediterranean countries. International Migration, 40(1):5-26

Imai, S.K., Gaiha,R., Ali, A., and Kaicker, N. (2012). Remittances, growth and poverty. New evidence from Asian countries. Disussion paper No 15, International Fund for Agricultural Development (IFAD)

Johannes , A.T., Vabi, B. M. and Malaa, K. D. (2010). Adoption of maize and cassava production technology in the forest-savannah zone of Cameroon: implication for poverty reduction. World Applied Sciences Journal, 11(2):196-209

Kimiri, L., Mathenge, M., Olwande, J., Gamba, P., Onnyuma, S., and Lagat, J. (2010). Globalization and structural change in rural economies, RuralStuc program-Phase II report, Egerton University, Kenya

Kudi,T. M., Bolaji, M., Akinola, M. and Nasa'l, D. H. (2011). Analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria. International Journal of Peace and Development Studies, 1(3):8-12

Langyintuo, A. and Mekuria, M. (2008). Assessing the influence neighborhood effects on the adoption of improved agricultural maize in developing countries. Afjare, 2(2):151-169

Losch, B., Freguingresh, S., and White, E. (2011). Rural Transformation and Late Developing Countries in a Globalizing World: A Comparative Analysis of Rural Change. Final Report of the RuralStruc Program, Revised Version. Washington, DC: World Bank

Mendola, M. (2006). Migration and technological changes in rural households: Complements or substitutes? Journal of Development Economics, 85:150-175

Miluka, J., Carletto, G., Davis, B., and Zezza, A. (2010). The vanishing farms? The impact of migration on Albania family farming. The journal of development Studies, 46(1):140-161

Mohapatra, S. and Ratha, D.(2011). Migrant remittances in Africa: An overview. The World Bank http://siteresources.worldbank.org/EXTDECPROSPECTS/Resources/476882-1157133580628/RemittanceMarketsInAfricaOverview.pdf. Accessed on Feb. 04, 2012

Nagarajan,G. and Meyer, R.L. (2005). Rural finance: Recent advances and emerging lessons, debates and opportunities. Rural version of working paper AEDE-WP-0041-05, Department of Agricultural, Environmental, and Development Economics, The Ohio State Unive rsity (Columbus, Ohio, USA).

Ncube, G. and Gomez, M.G. (2011). Local economic development and migrant remittances in rural Zimbabwe on sand or solid ground? Working paper No. 523, International Institute for social studies, the Hague, Netherlands

Nguyen,T. and Purnamasari,R.(2011). Impacts of International Migration and Remittances on Child Outcomes and Labor Supply in Indonesia How Does Gender Matter? Policy Research Working Paper 5591. Poverty Reduction and Economic Management Unit The World Bank East Asia and Pacific Region

Ouma, J.O., and De Groote, H. (2011). Determinants of improved maize seed and fertilizer Adoption in Kenya. Journal of Development and Agricultural Economics, 3(11), 529- 536

Plaza, S., Navarrete, M., and Rtha, D.(2012). Migration and remittances household survey in Sub Saharan Africa: methodological aspects and Main Findings. The World Bank, http://www.acpmigration-obs.org/node/3999. Accessed on March 2013

Ponsot, F., and Obegi, B. (2010). Etude de capitalization des initiatives et mecanismes en matiere de transfert de fonds. Center for International Cooperation and development, university of Pavia, Italy

Quinn, A.M. (2009). Estimating the Impact of Migration and Remittances on Agricultural Technology. The Journal of Development Areas, 43(1):200-216

Richter,S.(2008). The insurance role of remittances on household credit demand. Selected paper Prepared for presentation at the American agricultural Economics association Annual Meeting, Orlando, florida

Reardon, T. (1997). Using evidence of household income diversification to inform study of the rural nonfarm labor market in Africa. World development, 25(5), 735-747

Rubenstein, H.(1992). Migration, development and remittances in rural Mexico. International Migration, 30(2); 127-153

Simtowe, F. and Zeller, M. (2006). The impact of access to credit on the adoption of hybrid maize in Malawi: An empirical test of an Agricultural Household model under credit market failure. http://mpra.ub.uni-muenchen.de/45/ . Accessed on Feb. 12, 2013

Stark, O and Bloom, D.E. (1985). The New Economics of Labor Migration. The American Economic Review, (75): 173-178

Suri,T. (2011). Selection and comparative advantage in technology adoption. Econometrica, 79(1):159-209

Taylor, J. E. (1999).The new economics of labor migration and the role of remittances in the migration process. International Migration, 37(1):63-88

Taylor, J.E., Wyatt, T.J. (1996).The Shadow Value of Migrant Remittances, Income and Inequality in a Household-Farm Economy, The Journal of Development Studies, 32: 899-912

Wouterse, F. (2010).Migration and technical efficiency in cereal production: evidence from Burkina Faso. Agricultural economics, 41(5):385-395

Yang, D.(2008). International migration, remittances and household investment: evidence from Philippine migrants, exchange rate shocks. Economic Journal, 118(528): 591-630

Zahonogo, P. (2011). Migration and agricultural production in Burkina Faso. African Journal of Agricultural Research ,6(7): 1844-185

Zeller, M.(2003) Theme: Rural Finance Institutions and Systems: Models of Rural Financial Institutions. http://198-101-236-183.static.cloud-ips.com/files/20074_20074.pdf Access on 03 March 2013

Zhu, Y., Wu, Z., Wang, M., Du,Y., and Cai, F.(2011). Do migrants really save more? Understanding the impact of remittances on saving in rural China. The journal of Development Studies, 48(5): 654-672

Table 1: Number of Households with migrants and remittances

Type of migration	frequency	% of HH with Remittances (out of HHs with migrants)
No Migration	476	
Local migration	260	69.6
International migration	161	94.30
Total	897	

Source: By the author from Ruralstruc data

Table 2: Summary statistic of Key variables used in the study

Variables	**Obs.**	**Mean**	**Std.dev**
Adoption of new technologies(1=yes, 0=no)*	897	.702	.457
Number of local migrants per household	897	.518	.942
Number of international migrants per household	897	.631	1.061
HH with Local Remittances (1=yes, 0=no)	897	.202	.479
HH with International remittances(1=yes, 0=no)	897	.171	.376
Gender of the HH head(1=male,0=female)	897	.961	.194
Total active males in the household	897	3.269	2.22
Total active females in the household	897	3.496	2.201
Number of children in the household	895	5.869	3.799
Age of the household head	897	51.63	13.201
Annual household revenue	897	556.312	750.2
Household with marketing contract(1=yes,0=no)	897	.153	.359
Household uses mutual or unpaid labor(1=yes,0=no)	897	.211	.144
Household has access to animal plough(1=yes,0=no)	897	.115	.319
Hh has access to irrigation	897	.229	.421
Maize sales(log)	897	5.27940	1.34353
HH head has secondary school education (1=yes,0=no)	897	.0223	.144
HH head has post secondary school education (1=yes,0=n0)	897	.0044	.0667
Land owned(hectares)	897	.204	4.336
% of Land under farming(hectares)	897	.882	.821
% of Land under irrigation(hectares)	897	.092	5.402
Cattle owned	897	.7074	1.656
Household has access to tractor(1=yes,0=no)	897	.0011	.0333
Household is very poor(1=yes,0=no)	897	.7413	.4381
Migration percentage	897	.735	.0933
Household size	897	8.822	3.008
Household head is a member of social network(1=yes,0=no)	897	.789	.4080
Easy access to transport(1=yes, 0=no)	897	.399	.489
Dependency ratio	897	.647	.733

Source: By the author from RuralStruc data

*New farming technologies= improved seeds and fertilizer as a package

Table 3: Impact of migration on the adoption of new farming technologies

	Dependant variable: adoption of new farming technologies					
	2SLS		**2SLS**		**3SLS**	
Variables	**Coef**	**Robust Std. Err**	**Coef**	**Robust Std. Err**	**Coef**	**Robust Std. Err**
Internal migration(migrants per HH)	**.1305****	**.0607**			**.2348****	**.0105**
International migration(migrants per HH)			**.5939***	**.1796**	**.8150****	**.343**
Gender(1=male, 0=female)	.3584	.2405	.3169	.2416	**.3074*****	**.1435**
Active Male in Household	**.0652**	**.0258**	**.0725**	**.0262**	.0038	.0337
Active females in Household	.0058	.0263	.0021	.0257	.0394	.0294
Nb of Children in Household	-.0175	.0141	-.0187	.0142	.0041	.0158
Age of Household Head	-.0043	.0037	-.0026	.0036	**-.0695*****	**.0029**
Annual revenue of Household	.0833	.0606	.0489	.0669	**.1420*****	**.0627**
HH with Marketing Contract(1=yes, 0=no)	**.3237****	**.1451**	**.3178**	**.1426**	**.3403****	**.1481**
HH use mutual or unpaid labor	-.3154	.3222	-.2696	.3154	.3750	.3266
HH has access to Animal Plough(1=yes,0=no)	**.5713***	**.1729**	**.5452****	**.1697**	**.6340***	**.1709**
Access to irrigation	**.8291***	**.1647**	**.7504***	**.1569**	**1.005***	**.1743**
Total sales of maize	.0002	.0017	.0005	.0016	.0008	.0009
HH head finish elementary school (1=yes,0=no)	-.1186	.1220	.1217	.8141	.5304	.7236
HH head finish high school or Univ(1=yes,0=n0)	0.231	.561	.1680	.4803	.1728	.2630
Land owned(hectares)	-.0142	.0163	-.0152	.0154	-.0044	.0165
Land under farming (hectares)	**.0172****	**.0082**	.0138	.0084	**.0323****	**.0097**
Irrigated land (hectares)	.0129	.0149	-.0072	.0151	**.0478****	**.0192**
Nb. Of Cattles owned	**-.007****	**.0031**	**-.007****	**.0030**	**-.0650*****	**.0022**
Household is poor (1=yes, 0=no)	**-.341*****	**.1426**	**-.328****	**.0928**	**-.2323****	**.1037**
Constant	-.3511	.5883	-.0784	.6352	-1.0381	.7129
Number of Obs	*897*		*897*		*897*	
Chi-Squared	*75.09*		*74.59*		*78.48*	
Wald test for exogeneity	$\chi^2(1) = 7.61$ *(P-value* = 0.0025*)*		$\chi^2(1) = 5.76$ *(P-value* = 0.0130*)*			
Weak IV tests	*F(4,897)=96.1 (P-value = 0.0000*		*F(4,897)=65.03 (P-value = 0.0000*			
Hansen's J chi2(3)	*1.87762(p-value = 0.1685)*		*1.3456(p-value = 0.2873)*			

*,**,and*** denotes significance at 1,5 and 10% respectively

Table 4: Impact of remittances on the adoption of new agricultural technologies

	Dependant variable: adoption of new farming technologies					
	2SLS		**2SLS**		**3SLS**	
Variables	**Coef**	**Robust Std. Err**	**Coef**	**Robust Std. Err**	**Coef**	**Robust Std. Err**
Internal remittances(remittance per HH)	.00034	.00063			.0024	.0043
International remittances(remittance per HH)			**.0014***	**.00043**	**.0074****	**.0013**
Gender(1=male, 0=female)	.3237	.2443	.3731	.2857	.3290	.2920
Active Male in Household	**.0723****	**.0259**	**.0680****	**.0257**	**.0724****	**.0261**
Active females in Household	.0080	.0261	-.0036	.0297	.0075	.0300
Nb of Children in Household	-.0227	.0146	-.0218	.0241	-.0234	.0242
Age of Household Head	-.0045	.0037	-.0027	.0036	-.0045	.0037
Annual revenue of Household	.0222	.0731	.0344	.1144	**.2519*****	**.1165**
HH with Marketing Contract(1=yes, 0=no)	**.3454****	**.1455**	**.3024****	**.1453**	**.3459****	**.1456**
HH use mutual or unpaid labor	-.2698	.3203	-.2661	.3202	**.3684*****	**.0136**
HH has access to Animal Plough(1=yes,0=no)	**.6431***	**.1764**	**.5544****	**.1718**	**.6430***	**.1763**
Access to irrigation	**.8097***	**.1603**	**.7917***	**.1639**	**.8105***	**.1643**
Total sales of maize	.00004	.0002	.00004	.0002	**.0046*****	**.0002**
HH head finish elementary school (1=yes,0=no)	-.0342	.2105	.1141	.283	.2752	.6983
HH head finish high school or Univ(1=yes,0=n0)	.2749	.6986	.1963	.7025	.3008	.1712
Land owned(hectares)	-.0215	.0164	-.0169	.0168	.0216	.0169
Land under farming (hectares)	**.0170****	**.0082**	**.0162*****	**.00733**	**.0170****	**.0072**
Irrigated land (hectares)	-.0023	.0156	-.0076	.0185	.0298***	.0086
Nb. Of Cattles owned	**-.0062****	**.0031**	**-.0075**	**.0032****	**-.0069****	**.0032**
Household is poor (1=yes, 0=no)	**-.3101****	**.1456**	**-.3511****	**.1537**	**.21597***	**.0532**
Constant	.5299	.6841	.0123	.9153	.5503	.9353
Number of Obs	*897*		*897*		*897*	
Chi-Squared	*92.32*		*87.16*		*91.89*	
Wild test for exogeneity	$\chi^2(1) = 7.85$ *(P-value = 0.0063)*		$\chi^2(1) = 6.98$ *(P-value = = 0.0079)*			
Weak IV tests	*F(2,897)= 32.402 P-value= 0.0000*		*F(2,897)= 15.892 P-value= 0.0000*			
Hansen's J chi2(1)	*1.4282(p = 0.4986)*		*1.10561 (p = 0.75209)*			

*,**,and*** denotes significance at 1,5 and 10% respectively

Table5: Impact of Migration and Remittances on the adoption of new farming technologies

	Dependant variable: adoption of new farming technologies			
	Internal migration and remittances(3SLS)		**International migration and Remittances(3SLS)**	
Variables	**Coef**	**Robust Std. Err**	**Coef**	**Robust Std. Err**
Migration(migrants per HH)	**.1098****	**.0091**	**.8786***	**.1741**
Remittances(remittance per HH)	.0003	.0008	**.1539****	**.0004**
Gender(1=male, 0=female)	.3238	.2444	.3455	.2895
Active Male in Household	**.0717***	**.0264**	**.0716***	**.0259**
Active females in Household	.0071	.0273	-.0003	.0298
Nb of Children in Household	-.0224	.0148	-.0200	.0242
Age of Household Head	-.0044	.0037	-.0027	.0037
Annual revenue of Household	**.18041*****	**.0822**	.0449	.1152
HH with Marketing Contract(1=yes, 0=no)	**.3450****	**.1456**	**.3185****	**.1452**
HH use mutual or unpaid labor	.2713	.3206	-.2713	.3207
HH has access to Animal Plough(1=yes,0=no)	**.6404***	**.1785**	**.5574***	**.1719**
Access to irrigation	**.8105***	**.1606**	**.77805***	**.1637**
Total sales of maize	.00004	.00017	.00004	.0002
HH head finish elementary school (1=yes,0=no)	-.1801	.293	.1127	.2685
HH head finish high school or Univ(1=yes,0=n0)	.2684	.7003	.1445	.7109
Land owned(hectares)	-.0210	.0168	-.0161	.0168
Land under farming (hectares)	**.0170****	**.0082**	**.0149*****	**.0064**
Irrigated land (hectares)	-.0029	.0163	-.0075	.0185
Nb. Of Cattles owned	**-.0072****	**.0031**	**-.0072****	**.0031**
Household is poor (1=yes, 0=no)	**-.1291*****	**.0460**	**-.1376****	**.0539**
Constant	.49095	.7664	-.0554	.9200
Number of Obs	*897*		*897*	
Chi-Squared	*76.94*		*69.71*	

*,**,and*** denotes significance at 1,5 and 10% respectively